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Description pages 1, 2, 3, 4 revised 15 August 2003

A blood pressure measuring implement.

The invention concerns apparatus for measuring blood pressure, comprising a generally tubular constrictable sleeve or cuff for a limb of a person, a source for fluid pressure, means for measuring static pressure, and microphone means arranged in proximity to an artery.

Modern blood pressure measurements have long traditions and fall into two distinct types. Both the auscultatory and the oscillometric method use the constriction of an artery to such a degree that blood flow is stopped and then allowed to flow while a signal derived from the blood pressure is monitored. The constriction occurs by means of a cuff surrounding a limb (in most cases an upper arm or a wrist). The cuff has a non-stretchable fabric on the outside enclosing an elongate bladder surrounding a large part of the limb periphery. The bladder is pressurised by means of air, and the air pressure is monitored. The Korotkoff method depends on listening to sounds in the artery downstream of the constriction as blood begins to flow, and to read the pressure when certain sounds related to the heartbeat are heard and again when sounds begin to disappear. Traditionally, the listening has occurred by means of a stethoscope, the chestpiece of which is held against the skin in proximity to the artery downstream from the occlusion, frequently supported against the edge of the cuff.

The above process of measuring blood pressure is perceived as a slow process and one which requires skill. This is due to the manipulation, requiring two hands, involved in fitting the cuff, and the need for precise placement of the stethoscope chestpiece. The pumping and release of air are perceived as the least time consuming, particularly because they pertain to the actual measurement. Modern measurement methods use automatic pumping and release and electronic microphone pickup of the Korotkoff sounds and possibly some signal processing aids in distinguishing between the various types of sound.

US 4,337,778 describes an attempt to reduce the entanglement of air tube and microphone lead in connection with the wrapping and unwrapping of the cuff, in that the Korotkoff sounds are picked up by means of a microphone inside the inflatable bladder. However, the patent does not attempt to solve the fundamental time-consuming problem of the wrapping and unwrapping for the single-handed individual.

In US 5,560,365 it is described how the provision of a partially stretchable cuff may reduce friction noises in case the blood pressure measurement is performed on a non-stationary limb. It improves the signal to be analysed, but it does not solve the problem of fitting the cuff.

In US 4,248,242 it is described how a blood pressure apparatus may be semi-automated by means of a sequential switch and hand pump arranged on apparatus integrated with the cuff. The cuff itself still has to be threaded on the arm. A sensor is provided for picking-up the Korotkoff sounds but there is no indication of the manner in which it is fitted to the apparatus.

US 4,790,325 relates to an automatic blood pressure recorder, in which the patient is required to sit and place his arm in a solid fixture or jig integrated into an armrest and containing inflatable elements, said fixture being closed automatically by an equally solid clamp. This makes the equipment very stationary and ill suited for patients unable to sit upright in a chair-like construction.

It is hence an object of the invention to provide a cuff-and-microphone combination that is able to provide consistent good acoustic coupling and signal processing to obtain dependable artery sound signals. It is a further object of the invention to provide a cuff structure that is adaptable to a wider range of biometric measures of a limb than known apparatus. It is a still further object of the invention to provide an indication of a mismatch in case the biometric measurements serviced reliably by the cuff fall outside the limits of its adaptability and to propose a correction commensurate with the mismatch.

According to the invention the above deficiencies are avoided and the advantages obtained, in that the cuff is at least partly enclosed in two essentially concave shell parts displaying a stiffness along the limb, said shell part being openable against a restoring force, and in that a linear array of microphone elements is disposed on a universal joint type support in one shell part essentially perpendicular to the longitudinal axis of such shell part and near the lower end. The term "concave" refers to the fact that the shell parts may be straight axially along the arm, whereas they intendedly curve in the direction perpendicular to the axial direction along the arm. The term "stiffness" refers to the fact that it is not intended to give the shell a curvature in the axial direction that deviates from any curvature it may have been given during manufacture. A universal joint type support for a linear array perpendicular to an axis is characterised by permitting movement in a plane perpendicular to said axis as well as rotation about an axis along the linear array. There is a distinct advantage to using a stiff shell for enclosing the inflatable cuff, rather than the traditional woven strap, because the forces between the cuff and the limb (upper arm) are more evenly distributed and so facilitate a stable and repeatable occlusion of the artery. This is important both for the auscultatory and for the oscillometric method. In case of the auscultatory method the rotational precision required in fitting the implement is much reduced by providing several microphones in combination with the stiff shell, because it will at all times be possible to find the microphone which provides the clearest signal. There is a particular advantage to using such an array of microphones when the inflated cuff is retained by a stiff shell, because the repeatability of fitting the apparatus and of the readings are hugely increased. The implement may be entirely supported by a limb, i.e. without attachment to constructive elements carried by e.g. an arm rest.

According to an advantageous embodiment signal selection means of the diversity reception type are used to select the microphone that provides the best signal-to-noise ratio. Rather than averaging the output of the linear array of microphones it is much more efficient to select the microphone which at the same time receives the strongest signal but also the least amount of extraneous noise.

According to a further advantageous embodiment the microphone signal is amplified and made available to an electroacoustic converter for enabling listening to the

signal. This means that an examining physician may demonstrate to others, including the patient, the character of the Korotkoff sounds directly from the apparatus of the invention, rather than from a separate stethoscope.

According to a further advantageous embodiment the signal is output via a built-in speaker in the apparatus. This makes the apparatus completely self-contained.

According to a further advantageous embodiment the signal is output via a wireless link to a receiver connected to earpieces carried by an auscultating physician. Such a receiver/earpiece combination may typically be a part of an electronic stethoscope already carried by the physician and other medical staff surrounding the person whose blood pressure is measured by the present apparatus.

A further advantageous embodiment of the invention is particular in that it comprises signal processing means for combining information derived from measurements of slowly varying static pressures with information from said microphone means in order to obtain a numerical value for a blood pressure. This would typically include cycling the static pressure and obtaining a sound signal in dependence thereof, the frequency content of said signal determining the type of Korotkoff sound detected, and sampling said static pressure and combining with frequency content signatures sampled essentially simultaneously therewith will provide numerical information of the pressures required to obtain specific Korotkoff type sounds.

According to a further advantageous embodiment an inelastic strap attached to one shell part is provided to close the gap between the shell parts. The use of a strap is known per se from traditional cuffs, however, according to the invention its action is more consistent because it attaches the shell parts.

According to a further advantageous embodiment the strap is provided with means locking to the other shell part in conjunction with the overlapping of said strap and said other shell part. Such means would be of a quick-release type.

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PATENT CLAIMS

1. Apparatus for measuring blood pressure, comprising a generally tubular constrictable sleeve or cuff for a limb of a person, a source for fluid pressure, means for measuring static pressure, and microphone means arranged in proximity to an artery, characterised in that the cuff is at least partly enclosed in two essentially concave shell parts displaying a stiffness along the limb, said shell part being openable against a restoring force, and in that a linear array of microphone elements is disposed on a universal joint type support in one shell part essentially perpendicular to the longitudinal axis of such shell part and near the lower end.

2. Apparatus according to claim 1, characterised in that signal selection means of the diversity reception type are used to select the microphone that provides the best signal-to-noise ratio.

3. Apparatus according to claim 1 or 2, characterised in that the microphone signal is amplified and made available to an electroacoustic converter for enabling listening to the signal.

4. Apparatus according to claim 3, characterised in that the signal is output via a built-in speaker in the apparatus.

5. Apparatus according to claim 3, characterised in that the signal is output via a wireless link to a receiver connected to earpieces carried by an auscultating physician.

6. Apparatus according to claim 1, characterised in that it comprises signal processing means for combining information derived from measurements of slowly varying static pressures with information from said microphone means in order to obtain a numerical value for a blood pressure.

7. Apparatus according to claim 1, characterised in that an inelastic strap attached to one shell part is provided to close the gap between the shell parts.